



ULCO Postdoctoral fellowship 2021

Host laboratory within Université du Littoral Côte d'Opale:

Laboratoire d'Océanologie et de Géosciences (UMR 8187 ULCO/CNRS/U Lille)
Maison de la Recherche en Environnement Naturel, Wimereux, Northern France.

Supervisors :

Pr. Michaël HERMOSO (ULCO – UMR 8187 LOG).
Dr. Alice DELEGRANGE (INSPÉ – UMR 8187 LOG).
Dr. Fabrice Minoletti (Sorbonne Université – UMR 7153 IStEP)

Title of the research programme:

Pelagic calcite fluxes within the upper water column and implications for the Ocean-Atmosphere exchanges of CO₂ in the context of ocean acidification.

Duration: 12 months starting 01/01/2021.

Description:

This experimental project aims at studying a fundamental yet poorly quantified component of the carbon cycle: The export of particulate carbon (both organic and inorganic) biologically pumped and produced in the photic zone of the ocean and transferred toward bottom waters. Although the flux of atmospheric CO₂ dissolved in the ocean, fixed by photosynthetic organisms and transformed into particulate carbon is nowadays well quantified (as the biological pump), this carbon remains labile and can over an array of relatively short timescales be exchanged back to the atmosphere. The challenge of this project is to try to quantify via experimental cultures of calcifying micro-algae (**Coccolithophores, Haptophyta**), exposed to their zooplanktonic predators (**Copepods, Crustacea**), fluxes of particulate carbon that are exported in the faecal pellets of the latter animals under various environmental conditions. In a context of current and future climate change (pCO₂ increase and lowering ocean pH), it appears necessary to develop a holistic view of processes at play in the carbon cycle and of their modulation in the natural environmental habitat of these organisms. This project will study different aspects of the trophic interaction between two main key organisms in the functioning of the biological pump (soft tissue pump) and of the counter carbonate pump (hard tissue counter-pump).

The aims of this project lie within research themes of societal importance listed in group I of the IPCC on the effects of massive anthropogenic CO₂ release and notably on the impact of these emissions on calcifying ecosystems which are particularly sensitive to lowering ocean alkalinity as already observed today. Besides the strong link to Anthropocene climate change, this project will have implications for the understanding of the genesis of deep-sea carbonate deposits in the marine pelagic realm, for the reliability of paleoclimatic reconstructions that are essentially based on geochemical proxies derived from these carbonate deposits. It will indeed be possible to compare the morphology and the geochemistry of coccoliths that have been predated by copepods (sitting in faecal pellets) to that of those that have not been predated on cultures as well as to conduct a similar study of an obvious deep-time example from Jurassic sediments.

From a methodological point of view, the applicant will have to prepare and monitor *in vitro* cultures in controlled media (temperature, pCO₂ and pH) of the two organisms, and to compare coccoliths before and after predation (free coccoliths compared to those in copepod faecal pellets).

The objectives of the study are thus:

- To predict variations in the export fluxes of inorganic and organic carbon settled in the water column through faecal pellets under different scenarios of the IPCC (by conditions imposed to the mixed coccolithophores-copepods cultures).
- To quantify the preservation and changes in nannofloral assemblages caused by predation of the copepods (living and fossils)
- To identify whether the original stable isotopic composition of coccoliths (carbon and oxygen), used as paleoclimatic and paleoenvironmental proxies, is altered by the transit of coccoliths into the digestive system tract and faecal pellets of the copepods (these measurements will be in Paris).

This project is thus essentially based on experimental work (cultures) that will take place at the MREN of Wimereux for the cultures and in Paris (Sorbonne Université) for morphological and isotopic analysis of the coccoliths. The setting of the project will take place in parallel to a literature synthesis on the topic. The main steps of the lab work are:

- Setting up various cultures of coccolithophore strains to distinct environmental conditions of temperature, pCO₂ and pH
- Setting up the copepods to similar conditions
- Mixing up these two organisms and monitoring these cultures
- Dissection of faecal pellets
- Slide preparation of the faecal pellet content and of free coccoliths
- Morphometric analysis of the coccoliths (in collaboration with UMR CNRS-Sorbonne Université 7153 IStEP for slide digitization) – via optical and electronic microscopy.
- Isotopic analysis (C, O) of the calcite (in collaboration with Paris).

The geological angle of this project will consist in the isotopic measurement of coccoliths in cultures and in sediments. Despite the importance of potential bias on isotopic measurements of coccoliths, the impacts of the potential preferential

dissolution of carbonate tests, and calcite overgrowth that can occur within the digestive system tract or within the faecal pellets that were likely and potentially out of thermodynamic equilibrium with seawater, as well as bias in the coccolith assemblage, have never been studied. This project will allow an assessment of these potential biases that have strong implications for the reliability of paleoclimate proxies (such as coccolith calcite stable isotopes or coccolith morphological variations).

This project will also include the study of sediments that contain fossilized faecal pellets. These sediments are from the Jurassic (Toarcian, 184 Ma). They correspond to finely laminated, C_{org}-rich sediments. Fossilised faecal pellets appear under the form of millimetric whitish balls that can be sampled easily due to their distinctive colour from the brown matrix. The study will compare the preservation state and the assemblage of coccoliths (at the species level) between the faecal pellets and the matrix, with the assumption that coccoliths of the matrix have not settled to the sea bottom through a transport via faecal pellets.

This project that profits from an enhanced collaboration between the two axis Océanologie and Géosciences of the LOG (along with the collaboration with Sorbonne Université) will allow the applicant to blossom in a pluridisciplinary work environment and to develop a large port-folio of various competences that will be extremely useful for a future career of biogeochemist.

The profile of the applicant may be as much that of a marine biologist/ecologist as that of a sedimentary geologist. We're looking for dynamic and autonomous person, who likes lab work in order to conduct this pluridisciplinary and collaborative research project.

How to apply:

Please send a statement of interest (2 pages), a CV and the names of two or three referees to Michael.Hermoso@univ-littoral.fr no later than 25/11/2020.

Links :

ANR CARCLIM : https://anr.fr/fr/projets-finances-et-impact/projets-finances/projet/funded/project/anr-17-ce01-0004/?tx_anrprojects_funded%5Bcontroller%5D=Funded&cHash=989e30c2dc7b4679fa05e10ee4d4f4b4

UMR LOG : <https://log.cnrs.fr>

UMR IStEP : <http://www.istep.upmc.fr/fr/istep.html>